STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX O

HOUSTON-ATLAS MODEL 825R HYDROGEN SULFIDE ANALYZER

MONITORING AND LABORATORY DIVISION

SEPTEMBER 1985

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STATE OF CALIFORNIA

AIR RESOURCES BOARD

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VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX O.1

STATION OPERATOR'S PROCEDURES FOR THE HOUSTON-ATLAS MODEL 825R HYDROGEN SULFIDE ANALYZER

MONITORING AND LABORATORY DIVISION

SEPTEMBER 1985

O.1.0 GENERAL INFORMATION

O.1.0.1 PRINCIPLES OF OPERATION - The operation of the Houston Atlas Model 825R Hydrogen Sulfide (H_2S) analyzer is based upon the principle that H_2S will react with lead acetate tape causing a brown stain to appear on the surface. The rate of this stain formation determines the measure of H_2S concentration in the sample. A reading is produced electronically that is directly proportional to the H_2S concentration in the sample. This Appendix supplements the Manufacturer's Manual with instructions for servicing and troubleshooting the Houston Atlas 825R.

O.1.0.2 PHYSICAL DESCRIPTION- The Houston-Atlas 825R is housed in a table top cabinet approximately 20" wide x 10" high x 19" deep with a hinged top which lifts to access the tape transport, optical assembly, electronics, and bubbler (see Figure O.1.0.1). The only external component required is a sample pump.

Flow System - A Metal Bellows or equivalent sample pump, teflon line, and particulate filter are attached externally to the analyzer. An air sample is conditioned and humidified in a bubbler containing 5% acetic acid solution. The humidified air sample is channeled over the surface of an exposed portion of lead-acetate tape, then out through the sample vent.

NOTE: The sample vent must be unrestricted and without bends or loops which could trap or collect condensation causing flow irregularities.

Tape Transport Assembly - The tape transport assembly consists of a supply reel, a take up reel, the trigger slide and tape drive gear box. The tape drive is magnetically coupled to the drive motor, which pulls a fresh section of tape into the chamber with the start of each sampling cycle. The trigger slide forms a positive seal around the aperture of the chamber.

Optical System - The optical system contains a light source, two photocells, a primary lens tube, and a reference tube. The light source is a standard 14V tungsten filament lamp operating at 6 VDC ($\pm$0.2V) to extend the life of the lamp. The light is focused through the primary lens tube for complete illumination of the sample chamber aperture and tape, where it reflects off the tape's surface and onto the surface of the measuring photocell. Simultaneously, the reference tube directs the light beam to the reference photocell, thus compensating for any fluctuations in light intensity. Both photocells are factory matched to compensate for temperature shifts.

Balancing is achieved by varying the amount of light that falls on the reference photocell. Signals developed by the photocells in the optical system are differentiated by the preamplifier/differentiator board to provide a rate of change proportional to the H_2S in the sample.

Front Panel (see Figure O.1.0.2) - The front panel contains a zero and span control and photocell test jacks. (Units other than ARB may have the zero and span pots on a circuit board inside.) The flow meter is located in the center of the front panel. The readout meter, alarm set switches, power switch, amp function and tape drive controls are located on the left side of the front panel.

Rear Panel (see Figure O.1.0.3) - The power cord connection, signal output, alarm outputs, and sample inlet and exhaust are all located on the rear panel and are clearly identified.

O.1.0.3 ANALYTICAL CYCLE - At the beginning of the sample cycle, the tape drive motor energizes, advancing a clean section of tape into the sample chamber. The pump feeds the sample through the flow meter where flow is regulated, then through the acetic acid bubbler where the sample is conditioned. The conditioned air sample reaches the sample chamber where it passes over the lead-acetate tape surface. Here, H_2S reacts to form a brown stain on the exposed lead-acetate tape. The rate of this reaction is then measured by the rate reading electronics. The differential signal is processed by the electronics to produce a voltage value. When in "memory", the read-and-hold circuit-memory is activated to produce a reading that is directly proportional to the concentration of H_2S in the original sample. When in "rate read" mode, the typical reading is a steady rise to a final level output. When in "memory" mode, the output to meter and recorder will update once each cycle and hold the level until the next cycle. An ARB analyzer's cycle time is between three and four minutes.

If the H_2S level is above or below the manually adjustable preset alarm threshold, the high or low alarm lights will illuminate.

O.1.0.4 CAUTIONS

1. This analyzer operates on 110 VAC. Use a third-wire ground on this analyzer and observe all standard voltage safety precautions.

2.. The sensing tape used in the Model 825R analyzer contains lead; observe handling precautions as listed on tape package.

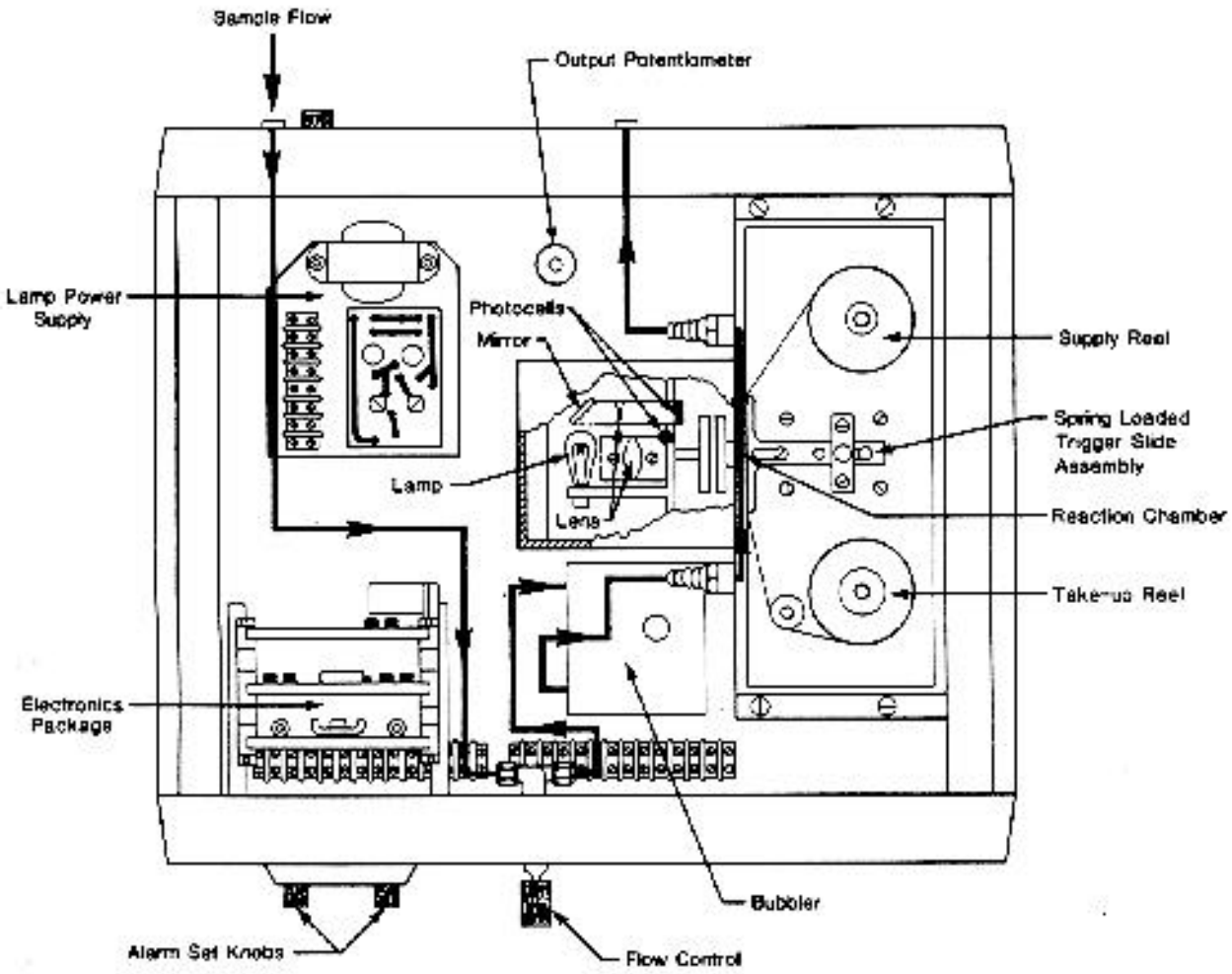

Figure O.1.0.1
Model 825R Interior Layout

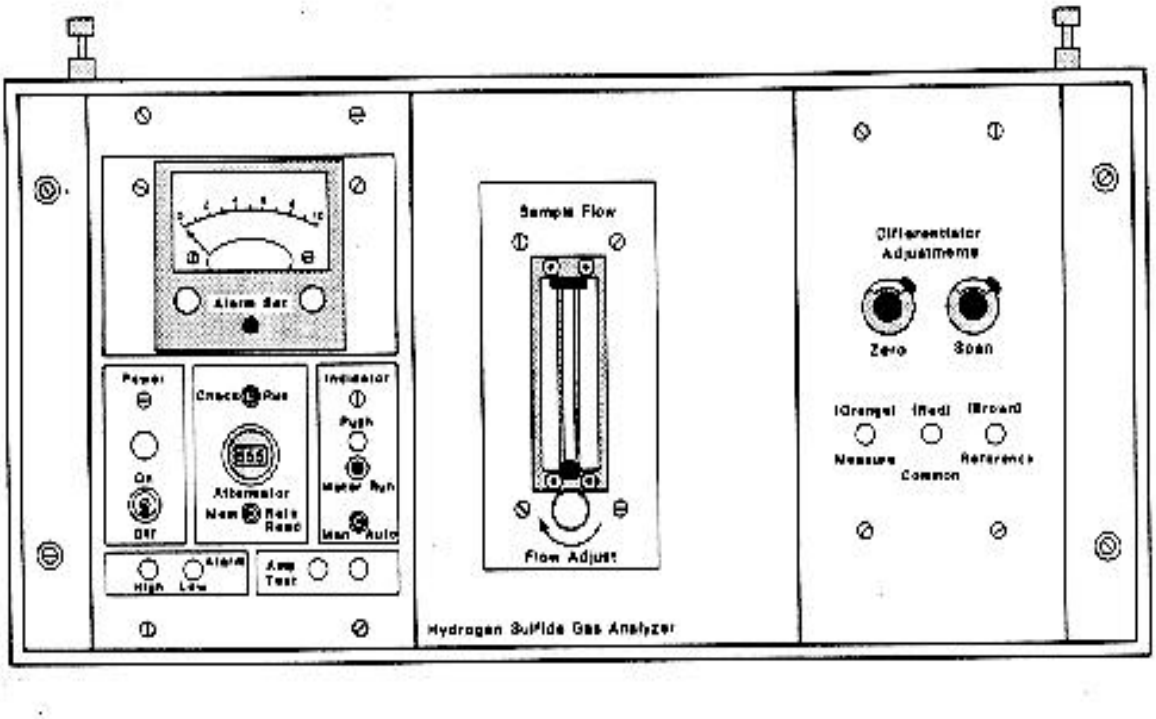

Figure O.1.0.2
Hydrogen Sulfide Gas Analyzer (Front Panel)

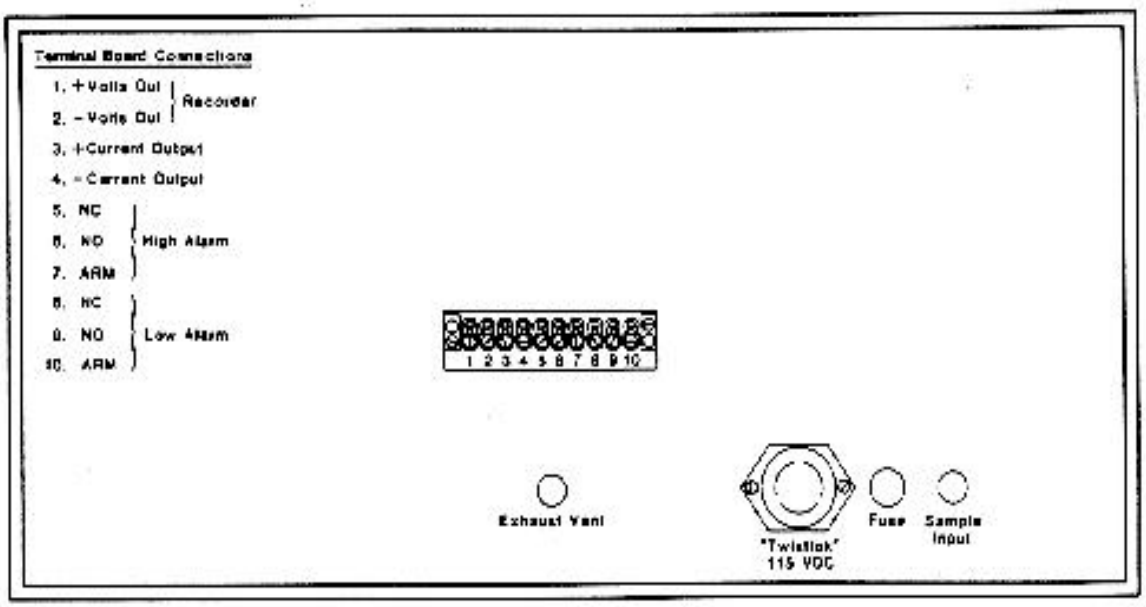

Figure O.1.0.3
Hydrogen Sulfide Gas Analyzer (Rear Panel)

O.1.1 INSTALLATION PROCEDURE

O.1.1.1 PHYSICAL INSPECTION - Unpack the analyzer and check for external shipping damage. Verify the analyzer is complete upon receipt. Open the hinged lid and check optical and electronics boards to assure they are not loose or damaged.

O.1.1.2 INITIAL SET UP

1. Connect a Metal Bellows or equivalent sample pump and teflon sample line to an inlet particulate filter, and attach filter to the analyzer inlet port. Plug in power cord to back panel and to 115 volt outlet. Connect signal cable to recorder from terminal strip on rear of analyzer. On ARB analyzers, a potentiometer on the inside rear of the cabinet may be used to adjust the recorder output to a maximum of 10 volts D.C. Once set to match recorder, it must not be moved, as it will alter the analyzer calibration.

2. Fill bubbler to indicated line with 5% acetic acid solution, load tape into tape transport and set attenuator dial and flows to values indicated on calibration sticker. (See Section O.1.2.4 for detailed instructions and Section O.3.0 for calibration instructions.)

O.1.2 ROUTINE SERVICE CHECKS

O.1.2.1 GENERAL INFORMATION - Perform the following routine service checks at the intervals specified in the service schedule (Table O.1.2.1). Checks may be performed more frequently, but should be performed at least at the prescribed intervals. The Monthly Quality Control Maintenance Checksheet (Figure O.1.2.2) should be completed and forwarded to your supervisor monthly.

O.1.2.2 DAILY CHECKS

1. Verify that the flow meter reads the correct flow as indicated on the most recent calibration report. Record the flow meter reading weekly.

2. Verify that the switches in the amp function section on front panel are in "Run" and "Memory", tape drive section switch in "Auto".

3. Verify attenuator dial at correct setting as indicated on latest calibration report and alarm lights off.

4. Verify tape supply reel and bubbler fluid level are sufficient to last until next visit to site.

O.1.2.3 WEEKLY CHECKS

1. Sample Inlet Particulate Filter - At least once a week, replace the teflon sample particulate filter.

   NOTE: Check the filter cleanliness and adjust the replacement frequency accordingly. Change the filter if even a slight particulate coating or discoloration is visible.

O.1.2.4 BIWEEKLY CHECKS (EVERY TWO WEEKS)

1. Change sensing tape.

   a. Unscrew knurled knob on the tape transport cover. Remove cover by lifting vertically.

b. Remove used tape from take-up reel. (Hold back trigger slide if supply reel not completely empty.)

c. Place empty spool from supply reel to take-up reel. Spool should be loose at this time.

d. Clean sample chamber window with Q-tip and alcohol and/or water while holding back the trigger slide. Stronger solvents may damage plastic window.

e. Place new roll of lead-acetate sensing tape on supply reel and pull the free end out about one foot. While holding back trigger slide, insert the free end of tape into space between slide and window then release slide. Advance tape far enough to insure clean, uncontaminated tape is at the sample chamber window.

f. Use cellophane and masking tape to attach the free end of sensing tape to take up reel spool. Turn spool counterclockwise to pull up slack then press spool tightly onto take up reel.

g. Replace cover and tighten knurled nut.

h. Advance tape using "motor run" button on front panel to take up any additional slack and insure motor operation.

2. Refill Bubbler

a. Remove plastic press fit cap from bubbler chamber. Insert a small, clean funnel into opening and fill with 5% acetic acid solution to fill line marked on side of container. Do not overfill. If no funnel is available, bubbler can be filled with a plastic squeeze bottle with a long spout. Wipe up any spills immediately. Replace cap.

3. Zero Check

NOTE: If the Model 825R is in the Memory Readout Mode, time must be allowed for the Electronics to update. DO NOT MAKE ANY ADJUSTMENTS unless three consecutive readings are essentially the same.

a. Turn "Check/Run" switch in amp function section to "Run" position.

b. Using flow adjust valve, turn off sample flow. Allow readout to level out. Reading should be zero or between zero and 2% of scale for recorders requiring offset for negative drift. If not, refer to Detailed Maintenance and Adjustment Procedures, Section O.1.2.

4. Electronic Cal Check

a. Turn range attentuator switch to zero. Turn "Check/Run" switch in amp function section to "check" position and allow sufficient time for readout to level out. If reading equals the check reading recorded on calibration tag on front of instrument, return function switch to run. If not, refer to Detailed Maintenance and Adjustment Procedures, Section O.1.2.

5. Light Beam Alignment

Check light beam for centering on the optics sample window. Realign if necessary. Refer to Section O.1.2, Detailed Maintenance and Adjustment Procedures.

6. Measure Photocell Resistance

a. Push motor run button on front panel to manually advance tape to clean section.

NOTE: Amp function switch MUST be turned to CHECK to prevent damage to test meter.

b. Using VOM on 1K to 5K ohm range, measure resistance between red and brown test jacks on right side of front panel (see Figure O.1.0.1). Record this value as <u>reference</u> photocell resistance.

c. Measure resistance between orange and red test jacks. Record this value as <u>measuring</u> photocell resistance.

d. The two values should be equal. If the photocells are more than 50 ohms out of balance, refer to Detailed Maintenance and Adjustment Procedures in Section O.1.3.

O.1.2.5 QUARTERLY CHECKS

1. Leak Check Unit

   a. Test for leaks at internal fittings using leak detection fluid, being careful not to spill or contact electrical components or connections.

   b. The pump may be leak checked by capping the pump's air intake. Any air pumped into the bubbler will indicate a leak. If the condition cannot be corrected, the pump should be replaced.

2. Clean all inside areas of dust and lint. Clean film buildup off tungsten lamp and glass optical components. Clean out residue buildup in bubbler which can occur in some environments. Return to service by making adjustments described in Section O.1.1.4.

O.1.2.6 MULTIPOINT CALIBRATION

Semi-annually perform multipoint calibration as outlined in Appendix C.3.0.

Table O.1.2.1
Houston-Atlas Model 825R H_2S Analyzer Service Schedule

	Daily*	Weekly	Biweekly	Quarterly	Semi-annually
Sample Flow	X				
AMP Function "Memory"	X				
Tape Drive "Auto"	X				
Check Tape & Bubbler	X				
Replace Filter		X			
Replace Tape			X		
Refill Bubbler			X		
Zero Check			X		
Electronics Cal			X		
Light Beam			X		
Photocell Resistance			X		
Clean Bubbler & Unit				X	
Leak Check**				X	
Multipoint Calibration**					X
Replace Tungsten Lamp			As Required		
Service or Replace Sample Pump			As Required		

*Or each day the operator services the analyzer
**Or as required after repairs

CALIFORNIA AIR RESOURCES BOARD
MONTHLY QUALITY CONTROL CHECKSHEET
HOUSTON ATLAS MODEL 825R NITROGEN SULFUR ANALYZER

Location_____ Month/Year_____
Station Number_____ Technician_____
Analyzer Property Number_____ Agency_____

			Date					
Replace Filter								
Amp Check Level			%Chart					
Sample Flow			As Found					
			Final					
Zero		As Found	Dial					
			Chart ppm					
		Final	Dial					
			Chart ppm					
Span		As Found	Dial					
			Chart ppm					
		Final	Dial					
			Chart ppm					
Attenuator Dial			As Found					
			Final					
Reference Photocell Ohms			As Found					
			Final					
Measuring Photocell Ohms			As Found					
			Final					
Ohms Difference (Must be less than 50 Ohms)			As Found					
			Final					

1. Daily Checks - Sample flow, check tape, bubbler, lamp on, switches, in "Run", "Memory", and "Automatic" modes.
2. Weekly Checks - Change particulateilter, record flow and amp check readings.
3. Biweekly Checks - Zero and span, centered light beam, photocell balance. replace tape, refill bubbler. Date last performed _____ .
4. Quarterly Checks - Leak check, clean bubbler and unit. Date last performed_____.
5. Six Month Checks - Multipoint calibration. Date of last calibration_____.

Date	Maintenance

Figure O.1.2.2
Houston Atlas Model 825R Hydrogen Sulfide Analyzer Monthly Quality Control Checksheet

O.1.3 DETAILED MAINTENANCE AND ADJUSTMENT PROCEDURES

O.1.3.1 OPTICS ALIGNMENT

1. Place amp function switch to "check" and turn range attenuator dial to zero.

2. Using manual run button, advance clean section of tape to optic chamber.

3. Remove optics cover by loosening two screws and lifting up and away from tape deck.

4. Clean optics with a soft cloth. The lens must be free of dust, dirt, or smears.

5. Check light beam to assure it centers on sample chamber with approximately equal overlap on each side and no shadow areas. If beam is centered, skip the next two sections.

O.1.3.2 CENTERING OF LIGHT BEAM

1. Set the large lens tube so that it is perpendicular to the mounting plate.

2. Loosen the two screws in the lamp bracket. Adjust the placement of the lamp until the light beam is centered on the sample chamber window.

3. Retighten the two screws GENTLY until they are snug. If the light beam remains centered, skip Section O.1.3.3.

   CAUTION: Over-tightening of screws will result in lamp breakage.

O.1.3.3 FINE CENTERING ADJUSTMENTS OF THE LIGHT BEAM

1. Loosen the set screw in the top of the Optics Mounting Plate that secures the main lens tube. This set screw should be just loose enough to permit side-to-side movement of the rear of the lens tube.

2. Move lens tube from side-to-side to achieve fine centering. The light beam must be centered up-and-down as well as side-to-side.

3. The light beam MUST completely fill the sample chamber window without any shadow from the edge of the window, and with normal overlap. If the light beam does not fill the window, slide the lens BACKWARD. If the light beams overlaps, slide the lens FORWARD.

CAUTION: Do not move the light beam off center!

4. If adjustment was necessary, the photocells will require rebalancing (see Section O.1.3.5).

O.1.3.4 PHOTOCELL BALANCE CHECK

1. Refer to Section O.1.2.4.6 - Measure Photocell Resistance.

O.1.3.5 PHOTOCELL BALACING

1. The measuring photocell resistance is established by the amount of light reflected from the sensing tape's surface. To balance the photocells, you must change the amount of reflected light falling on the reference photocell. This is accomplished by the coarse and fine adjustments.

2. Plug the test meter into the red and brown test jacks, and loosen the set screw that secures the reference tube.

3. Rotate the reference tube. This changes the amount of light falling on the photocell. Continue rotating the reference tube until the resistance reading on the meter closely matches the measuring photocell's resistance.

4. Hold the reference tube firmly in place with one hand, and with the other, tighten the set screw.

5. To make the fine adjustment essential to photocell balancing, loosen the slotted screw that holds the reference tube lens in place. Slide the lens forward or backward to achieve photocell balance. Tighten the lens holding screw. Replace the optics cover and close the lid of the analyzer.

6. With clean lead-acetate sensing tape in the sample chamber window, recheck measuring photocell resistance to verify it is within 50 ohms of reference photocell reading. If more than 50 ohms difference, repeat Section O.1.3.5.

O.1.3.6 FLOW METER CLEANING

Periodically, the flow indicator tube of the flow meter may appear dirty and need cleaning. To do so, use the following procedures:

1. Disassembling the Flow Meter:

   a. Relieve all pressure to the flow meter by turning off the source of supply. Unfasten and remove the plastic front cover from the flow meter.

   b. Use an allen head wrench to loosen the set screw at the top of the flow meter.

   c. Remove the flow tube and the rubber seals located at the top and bottom of the housing.

   d. Carefully remove the float retainers and float from the flow tube. Note that the top retainer is smaller than the bottom retainer.

   e. Thoroughly wash all parts in alcohol, then blow dry with clean air. (They may be laid aside and air-dried, provided sufficient time is allowed for thorough drying.)

2. Reassembling the Flow Meter:

   a. Carefully replace the rubber seals in the flow meter housing. The guides in the center of each seal must be in place and protruding above the surface of the seal.

   b. Replace the float and retainers into the flow tube, with the larger retainer going to the bottom.

   c. Install the flow tube in the flow meter housing. Use the guides on the scales to center the tube.

   d. Snug down the allen set screw.

   e. Fasten the plastic front cover and mounting bracket.

O.1.3.7 ELECTRONICS ADJUSTMENT

To gain access to the electronics, open the lid of the 825R analyzer to locate the electronics module in the left, front corner.

1. Pre-Amplifier/Differentiator Board

There are two adjustments on this printed circuit board: 1) Differentiator Zero, and 2) Differentiator.Span

NOTE: On California ARB modified analyzers, these adjustments have been moved to the front panel and are labeled Differentiator adjustments, Zero and Span.

a. Differentiator zero:

1) Turn the sample flow off.

2) Turn the Model 825R function switch to the run position.

3) Switch the readout selector to the rate read output mode. Allow the reading to stabilize before making any adjustment. (For zeroing and setting the differentiator span, the analyzer may be in the memory mode but this requires more time since the reading is up-dated only once per cycle. The analyzer should also be in the automatic run mode if adjustments are made in the memory mode.)

4) Turn the zero pot clockwise to cause the reading to become more negative, or counterclockwise to cause the reading to become more positive.

5) The zero level may be read on the recorder or the meter located on the front panel of the module.

6) Zero should be set on zero or between zero and 2% of scale for recorder requiring an offset for negative drift.

b. Differentiator span:

1) Turn the Model 825R function switch to the check position and the range attentuator to zero.

2) Allow 15 minutes for the reading to stabilize. It should equal the check reading noted on the calibration data tag.

3) Switch the readout selector to the rate read output mode. Allow the reading to stabilize before making any adjustment. (For zeroing and setting the differentiator span, the analyzer may be in the memory mode, but this requires more time since the reading is updated only once per cycle. The analyzer should also be in the automatic motor run mode if adjustments are made in the memory mode.)

4) Turning the differentiator span potentiometer clockwise increases the reading; counterclockwise decreases the reading.

IMPORTANT: This adjustment should only be used when the entire system is being recalibrated.

NOTE: Alarms are not normally used in normal ambient air monitoring. If needed, refer to manufacturer's operating manual for procedures.

O.1.3.8 ANALYZER SHUT DOWN PROCEDURE

1. In the event that the entire analyzer system must be shut down for an extended period, the following step-by-step procedure should be used.

   a. Turn off power switch.

   b. Turn off sample at sample inlet.

   c. Disconnect power cord.

   d. Disconnect sample inlet line and plug line and inlet port.

   e. Remove 5% acetic acid solution from the bubbler.

f. If the analyzer is to be idle longer than one week, remove the sensing tape. Retain one of the cardboard spools in the tape transport.

g. Close and secure cabinet.

2. Other Adjustments - Detailed instructions for less routine adjustments such as motor run time adjustment, lamp voltage regulator, or cycle time adjustment can be found in Section 4 of the Houston-Atlas 825R Manual.

O.1.4 TROUBLESHOOTING

O.1.4.1 GENERAL INFORMATION - The Manufacturer's Instruction Manual contains information pertaining to troubleshooting and should be your first source of information. Space is provided on the Monthly Quality Control Checksheet for recording malfunctions, causes, fixes, and actions taken to prevent recurrence.

Cautions listed in Section O.1.0.5 should be observed while performing troubleshooting or maintenance on the analyzer.

O.1.4.2 TROUBLESHOOTING GUIDE

Symptom	Probable Cause	Fix
Low or no output:	No power Blown Fuse	Replace fuse.
	Faulty wiring connection	Rewire power connection.
	Continuity in wiring between analyzer and recorder	Replace wiring or repair fault.
Recorder and Meter Both Read Low:	No H_2S in sample No sample flow through analyzer	Check flow settings.
	No H_2S tape in tape transport	Replace tape.
	Sample leaks	Tighten fittings or replace worn tubing.
	Improper operation of pre/amp differentiator board	Replace board
	Improper operation of timer/memory board	Replace board.
	Photocells out of balance	Balance photocells.
	Bubbler solution not made with deionized water, or the solution is contaminated	Replace solution with proper amount acetic acid.
	Improper reading in check postion	Span differentiator.
	Low reading with calibration sample	Check for flow leaks.
Recorder reading drifts up/down:	Improper light beam alignment	Clean and align optics.
	No tape movement when motor runs	refer to “Symptom” column, this page. No tape movement.
	Photocell out of balance	Balance photocells.

Symptom	Probable Cause	Fix
No tape movement:	Faulty motor run relay	Replace relay.
	Faulty wiring	Repair wiring.
	Frozen motor	Replace motor.
	Motor capacitor bad	Replace capacitor.
	Faulty Timer/Memory board	Replace board.
	Movements of magnets independent of shaft position	Tighten magnets.
	Gear box bearing out of alignment	Loosen two screws and position bearsing so that magnet and shaft move more freely. Tighten screws.
	Gear box frozen up	Replace gear box.
	Gears stripped	Replace gear box.
	Ability to turn take-up reel on shaft. (It should not turn independently of shaft)	Tighten set screw.
	Ability to turn sprockets on shafts	Tighten set screws.
	Chain damage	Replace chain.
No light beam on tape:	Voltage at analyzer connection points	Trace power to source.
	Check fuse	Replace fuse.
	Broken wires	Replace wires.
	Loose connection at terminal strip	Tighten screw at terminal strip.
	Dirty lenses and bulb	Clean optics.
	Improper optics alignment	Align optics.

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX O.2

ACCEPTANCE TEST PROCEDURE FOR THE HOUSTON-ATLAS MODEL 825R HYDROGEN SULFIDE ANALYZER

MONITORING AND LABORATORY DIVISION

APRIL 1985

O.2.0 PROCEDURE

O.2.0.1 GENERAL INFORMATION - Before beginning acceptance testing of the analyzer, read the manufacturer's instruction manual and become familiar with the analyzer before attempting its operation. Start an analyzer acceptance test mini report (see Figure O.2.0.1) and an acceptance test progress report.

O.2.0.2 PHYSICAL INSPECTIONS - Unpack the analyzer from its shipping carton and check for shipping damage before proceeding with the test. Report any damage observed.

1. Check the analyzer for compliance to the physical specifications listed as part of the purchase order and insure that the analyzer is complete as ordered (i.e., manuals, covers, etc.).

2. Open the analyzer and check for loose or damaged circuit boards, proper wiring of the input power receptacle, and tightness of tubing fittings.

   NOTE: Standard wiring configuration has the black wire connected to the brass terminal of the plug, white to copper, and green to ground. Verify that the analyzer is grounded to earth ground.

3. Assemble the analyzer as outlined in the manufacturer's instruction manual, including:

   a. Connect a pump to the sample inlet of the analyzer.

   b. Connect the recorder signal cables to the analyzer.

   c. Connect the sample line to the manifold.

O.2.0.3 OPERATIONAL TESTS - Perform the following checks and record the results on a mini report and on the strip chart which is retained in the Air Quality Surveillance files as a permanent record of the test performed. The data should be entered on the right-hand side of the strip chart preceding the test performed. The entry should follow the following format:

Title of the test being performed
Date
Make, model number, and serial number of analyzer under test
Range on which test is being performed

Clear, precise notations should be entered on the chart indicating when the tests were started and ended, pertinent information regarding sample flow, gas concentrations, voltages, interferent gases, etc., and any unusual condition observed. All strip charts should be cut in 24-hour sections. All tests should be run in parallel with a control analyzer.

1. Turn on the analyzer as outlined in the manufacturer's instruction manual. Check for proper operation of flow meter, integrator circuit, lamps, tape drive, and alarms. Note any obvious malfunction on the chart and the mini report.

2. Check the proper adjustment of the signal processing electronics as outlined in the manufacturer's instruction manual. Install tape in unit using procedure in Section O.1.2.4. Using a Vol-o-Flo, verify that the flow through the sample port corresponds to the reading of the flow meter on the front panel; adjust flow to .5 LPM.

3. Zero and Span Drift

   a. Establish stable zero and span (.4 ppm H_2S) traces on a strip chart recorder using appropriate repeatable sources.

   b. At intervals of 24 hours and 72 hours, repeat the above zero and span points. Deviations must not exceed manufacturer's specifications.

4. Temperature and Voltage Stability

   Place the analyzer in the Thermotron environmental chamber and connect the analyzer power cord to the variable voltage power strip. Run a temperature profile voltage test using H_2S span gas from the permeation tube source with Aadco zero air as diluent. Adjust flows to obtain an H2S chart trace of approximately 80% of full scale. After the temperature run is completed, transfer the voltage and temperatures from the temperature chart to the analyzer chart next to the appropriate section of the trace. The effect of temperature at 15°C and 35°C and the effects of voltage variation must meet manufacturer's specifications.

5. Linearity - After zero and span points have been set in the above test, run an auto program using the Dasibi Gas Calibration System to generate a range of four test concentrations. Verify from the strip charts that stable traces are being obtained at each point. Non-linearity (deviations from predicted concentrations) should not exceed $\pm$1% of full scale. The predicted H_2S concentration is obtained by using the reference analyzer's chart readings to

calculate dilution factors that are then multiplied by the test analyzer's initial H_2S chart reading. The following example illustrates the procedure.

	LINEARITY TEST						
	Reference_____				Test Analyzer		
		Gross	Net	Pred	Gross	Net	Pred
Level	0%	+.1			+.3		
(1)	80%	68.3	68.2	Base	73.5	73.2	Base
(2)	40%	34.6	34.5	34.1	37.2	36.9	37.0
(3)	20%	17.3	17.2	17.1	18.8	18.5	18.4
(4)	10%	8.1	8.0	8.5	9.2	8.9	8.6

i.e., the predicted H_2S value at level (2) =

$$\frac{34.5 \text{ (Ref. Net)}}{68.2 \text{ (Ref. Net)}} \times 73.2 \text{ (Test Net)} = 37.0\%$$

The non-linearity at this level is 36.9 - 37.0 = 0.1%.

O.2.0.4 FINAL REVIEW - If the tests are satisfactory, complete an equipment relocation notification tag and record pertinent information such as zero and span settings, attenuator dial setting, and flows in the log book and on the mini report. Also install label on front of instrument showing range amp check level, attentuator setting, and flow when calibrated.

The analyzer is now ready for field use.

HOUSTON ATLAS HYDROGEN SULFIDE ANALYZER

ACCEPTANCE TEST "MINI-REPORT"

Serial No. ____________

Date ____________ Make & Model No. ____________ Reviewed by ____________

By ____________ ARB No. ____________ Date of Acceptance ____________

	Passed	Failed	Final OK
I. PHYSICAL INSPECTIONS			
A. Checked for shipping damage			
B. Checked all electrical wiring			
C. Checked all plumbing for leaks			
D. Analyzer complete upon receipt			
II. OPERATIONAL CHECKS			
A. Checked operation of valves, controls, meters, pumps, switches, indicator lamps, etc.			
B. Set electrical zero and span			

III. TESTS PERFORMED (Attach Charts)	% FS Dev	Range	Pass	Fail	Final OK
A. 24 Hour Zero Drift					
B. 24 Hour Span Drift @ ______ ppm					
C. 72 Hour Zero Drift					
D. 72 Hour Span Drift @ ______ ppm					
E. Linearity (% FS Dev. from predicted)					
80% Full Scale					
40% Full Scale					
20% Full Scale					
10% Full Scale					
F. Temperature and voltage variation					
Zero Shift: 35°C, 115V					
35°C, 125V					
35°C, 105V					
15°C, 115V					
15°C, 125V					
15°C, 105V					
Span @ ______ ppm					
35°C, 115V					
35°C, 125V					
35°C, 105V					
15°C, 115V					
15°C, 125V					
15°C, 105V					

G. Final Analyzer Readings:

Tungsten lamp voltage + ______; Low Voltage Supply + ______ VDC; - ______ VDC

Flow: ______ SLPM @ ______ Flow Setting

Zero Dial ______ Span Dial ______ Attenuator Dial ______

IV. SPECIAL TESTS

V. COMMENTS/MAINTENANCE PERFORMED

ADD-69 (4/85)

Figure O.2.0.1
Acceptance Test Mini-Report

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES

FOR

AIR QUALITY MONITORING

APPENDIX O.3

CALIBRATION PROCEDURE
FOR THE
HOUSTON-ATLAS MODEL 825R HYDROGEN SULFIDE ANALYZER

MONITORING AND LABORATORY DIVISION

APRIL 1985

O.3.0 CALIBRATION PROCEDURE

O.3.0.1. INTRODUCTION - The Air Resources Board calibrates hydrogen sulfide (H_2S) analyzers using quantitative dilution, with air, of a compressed cylinder of H_2S gas (20 to 50 ppm). Zero air is mixed with the H_2S, using a calibrated dilution apparatus to provide a zero and four concentrations from 10% to 90% of the analyzer's operating range. The H_2S standard is initially certified against a NBS-SRM (SO_2 cylinder gas or permeation source) and thereafter, recertified at six-month intervals. The dilution apparatus (mass flow meters, etc.) is certified against laboratory flow standards and recertified every three months.

1. Sample Flow Rate: The analyzer sensitivity is directly dependent on the flow rate. The sample flow should not be less than 0.2 LPM nor greater than 0.5 LPM. Too low a flow will cause the analyzer to be slow to respond and may cause erratic readings. Too high a flow will sweep past the reaction area without allowing sufficient time for the reaction to occur.

2. Electronics Gain: Analyzer sensitivity can be increased (lower ppm concentrations to produce full scale reading) by changing the span. This adjustment changes the check reading. A higher check reading denotes more gain. The maximum check reading generally falls in the range of 4 to 5 volts DC. When increasing the span, care must be exercised. Too high gain (check readings) can produce noisy readings. The higher the gain, the more critical the photocell balance becomes.

3. Attenuator: Precise calibrations are made possible by varying the attenuator setting. The range depends on the specific analyzer and can easily be determined by trial.

O.3.0.2 APPARATUS - Figure O.3.0.2 is a schematic of a typical H_2S dynamic calibration system. Connections between components in the calibration system downstream from the H_2S cylinder should be of glass, FEP Teflon*, or other non-reactive material.

1. Dilution apparatus such as a Dasibi 1009 MC Calibrator or equivalent.

2. H_2S standard - Compressed gas cylinder containing 20 to 50 ppm H_2S in oxygen free N_2 with less than 0.005 ppm SO_2, less than 0.005 ppm oxides of nitrogen (NO plus NO_2), less than 1.0 ppm (each) of total hydrocarbons, CO,

*** Trademark of Dupont Corporation**

and CO_2, and having a maximum dew point of -40°C. The cylinder must be traceable to the National Bureau of Standards.

3. Zero Air - Air, free of contaminants which cause a detectable response on the H_2S analyzer or which might react with H_2S; provided by the Aadco zero air system, CSI calibration unit, zero air cylinder, or other pump and scrubber train.

4. One-quarter or one-eighth inch FEP Teflon tubing for airflow connections. All fittings in contact with H_2S must be made of 316 stainless steel or FEP Teflon*.

5. Calibration Datasheet (Figure O.3.0.1).

O.3.0.3 AS IS CALIBRATION - Other than routine daily checks, analyzer repairs of adjustments should not be made prior to the As Is calibration.

1. Record analyzer parameters and site conditions on the Calibration Datasheet (Figure O.3.0.1).

2. Purge the regulator and delivery system with H_2S to a safe vent after opening the cylinder valve.

   a. If possible, leave the regulator on the cylinder between calibrations (only if there is not transport involved).

3. Perform the appropriate analyzer electronic checks as outlined in Section O.1.2.

4. Using FEP Teflon tubing, connect the H_2S and zero air to the appropriate inlet fittings on the Dasibi 1009 MC.

5. Disconnect the analyzer's sample probe at the station's sampling manifold and connect it to the outlet manifold of the dilution apparatus. Cap the open port on the station's sampling manifold.

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CAUTION: Vent the excess H_2S from the outlet manifold to the outside using a large diameter vent line.

6. If using a zero air cylinder, attach and flush the zero air regulator, being careful not to introduce contamination.

7. Once the dilution air flow rate is chosen, determine the required flow of H_2S gas to obtain approximately 80% to 90% of full scale. (Use the following equation and those provided with the mass flow meter transfer standards. Record the mass flow meter equations on the Calibration Data Sheet.) Do not adjust the MFC to less than 10% of full scale.

$$FH_2S = \frac{(Co)\,(F_a)}{C_{cyl} - Co}$$

where: FH_2S = H_2S flow, sccm

F_a = Air flow, sccm

C_{cyl} = compressed H_2S cylinder concentration, ppm

Co = desired concentration (diluted H_2S concentration, ppm)

8. Open the air regulator outlet valve on the dilution apparatus; set the flow so that when the H_2S gas flow rate is at its maximum, the diluted H_2S concentration is calculated to be approximately 90% of full scale. The total flow must exceed the total demand of the analyzer(s) connected to the calibrator's output manifold to insure that no ambient air is pulled into the manifold vent (see caution note below). Allow the analyzer to sample zero air until a stable zero response is obtained. Adjust the analyzer's zero control to obtain the required zero set point on the chart recorder and again allow the analyzer to stabilize. Obtain approximately 10 minutes of stable recorder trace and record the response on the Calibration Data Sheet. If in "Memory" mode, allow a minimum of 3 cycles.

9. Adjust the H_2S gas flow (F_{H2S}) to the value calculated in Step 7 with the MFC potentiometer set to obtain approximately 90% of full scale. It may require an

hour or more for the reading to stabilize as the MFC, dilution apparatus, and analyzer must be conditioned to the calibration gas.

10. After the recorder chart response has stabilized, record the MFC displays and calculate actual sccm for the H_2S gas flow and dilution air flow, and the recorder chart response on the Calibration Datasheet.

11. Reset the H_2S MFC potentiometer to obtain responses of approximately 40%, 20%, and 10% of full scale. After the analyzer has stabilized for each test point, record the MFC displays and calculate actual sccm and the corresponding recorder chart response on the Calibration Datasheet.

12. Repeat the zero reference point (Step 8). Allow the zero trace to stabilize on the recorder chart. The zero response should reproduce the original zero to within 2% of full scale. If it does not, determine the cause and correct the problem before continuing (refer to Section O.1.3.2, Electronic Malfunctions).

13. Calculations:

NOTE: The calculations assume that the H_2S analyzer is linear, i.e., the calibration curve of the net chart recorder response versus concentration is a straight line within 1% of full scale at each point. If it is not, troubleshoot the analyzer and calibration system and correct the problem before continuing.

a. Calculate the H_2S and dilution air flow rates, sccm, using the certification equations provided.

b. Using the flow rates calculated for Steps 7 and 11, in sccm, and calculate the true H_2S concentration for each calibration point. Record under "$[H_2S]_{OUT}$" on the Calibration Datasheet.

$$\text{True } H_2S \text{ conc (ppm)} = \frac{C_{cyl} \times F_{H2S}}{F_{H2S} + F_a}$$

c. Determine the net DAS response in ppm by subtracting the average DAS zero response.

d. Calculate the deviation from true:

$$\% \text{ Dev} = \frac{\Sigma H_2S \text{ Net DAS}}{\Sigma [H_2S]_{OUT}} - 1 \times 100\%$$

Where Net DAS = Net Data Acquisition System

NOTE: Data for the above equations are recorded on the Calibration Data Sheet.

e. Calculate the least squares linear regression coefficients (slope and intercept) using all calibration points including zero points and record on the Calibration Data Sheet.

$y = mx + b$

Where x = true H_2S concentration, ppm = $[H_2S]_{OUT}$

y = Net DAS, ppm

m = slope (unitless)

b = y intercept, ppm

f. Calculate the "As-Is" change from the previous calibration:

$$\frac{\text{As Is Slope - Old Slope}}{\text{Old Slope}} \times 100\%$$

g. Plot the H_2S calibration curve, Net DAS or net chart versus $[H_2S]_{OUT}$.

h. If the slope, m, is between 0.95 and 1.05, and b agrees with the zero reading within 1% of full scale, then the analyzer is in calibration and no further adjustments are needed.

O.3.0.4 FINAL CALIBRATION - If the slope, m, calculated in Step 13e is less than 0.95 or greater than 1.05, an adjustment and final calibration are necessary. Adjust the H_2S analyzer to correct the deviation as follows:

1. Adjust flow to manufacturer's recommended setting.

2. Repeat the 80% of full scale span concentration (Section O.3.0.3, Steps 9 and 10).

3. Adjust the front panel span pot or attenuator control until the analyzer reads the true H_2S concentration.

NOTE Increasing the span pot or attenuator setting increases the analyzer's response.

4. Repeat the zero reference point (Section O.3.0.3, Step 8), readjusting the front panel zero control as necessary.

5. Repeat Steps 1 to 3 in this section until no further adjustments are needed.

6. Repeat calibration points (90%, 50%, 20%, and 10% of full scale) for the final calibration. Complete the Calibration Datasheet and a calibration curve.

7. If the analyzer span and/or attenuator control cannot be adjusted to provide the necessary corrections, then the analyzer may be in need of maintenance (such as optics, relaignment, cleaning, etc.). Troubleshoot for possible malfunctions (refer to Section O.1.3, Troubleshooting). Recalibrate after maintenance is performed, repeating Steps 1 to 5 of Section O.3.0.4.

O.3.0.5 COMPLETION - Return the analyzer to normal service. The new flow setting should be noted on a new calibration datasheet. The label on front of the analyzer should be supplemented with new dial and flow settings.

CALIFORNIA AIR RESOURCES BOARD

DYNAMIC H_2S CALIBRATION DATA SHEET

Site Name _____ Calibration: As Is [ ] Final [ ]
Site No. _____ Date _____ Log No. _____
Site Temperature _____ Barometric Pressure _____ Site Elevation _____

INSTRUMENT: Make and Model _____ Property No. _____
Serial No. _____ Span _____ Zero _____
Range _____ Airflow _____ l/min. at _____ setpoint
Attenuator Setting _____ Electronic Span _____ % F.S.
Primary Data Acquisition System (DAS): Make and Model _____
Property No. _____ Serial No. _____

TRANSFER STANDARD: Make and Model _____ Property No. _____
Serial No. _____ Date Certified _____ Cert. Expires _____
0-100 sccm MFC: Airflow = _____ x Display ± _____ sccm (H_2S gas)
0-10 slpm MFC: Airflow = _____ x Display ± _____ slpm (dilution)

COMPRESSED GAS CYLINDER: Cylinder No. _____ Cylinder Pressure _____ psi
Assay _____ ppm. Date Certified _____ Cert. Expires _____
Outlet Pressure _____ psi

DILUTION AIR: Source _____ Property No. _____
Outlet Pressure _____ psi

Transfer Standard					$[H_2S]$	Instrument		
H_2S Gas Flow		Dilution Flow		Total Flow	OUT	Chart	DAS	Net
Display	sccm	Display	sccm	sccm	(ppm)	(% FS)	(ppm)	DAS

Percent deviation from true: $\left(\frac{\Sigma H_2S \text{ Net DAS}}{\Sigma [H_2S]_{out}} - 1\right) \times 100\% =$ _____ %

Linear regression: Analyzer response (ppm), = (Slope) ($[H_2S]_{out}$) ± (Intercept) ppm

As is change from previous calibration, dated _____:

$\left(\frac{\text{As Is Slope - Old Slope}}{\text{Old Slope}}\right) \times 100\% = (\quad) \times 100\% =$ _____ %

Comments: _____

_____

_____ Calibrated by: _____ Checked by _____

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Figure O.3.0.1

Dynamic H_2S Calibration DataSheet

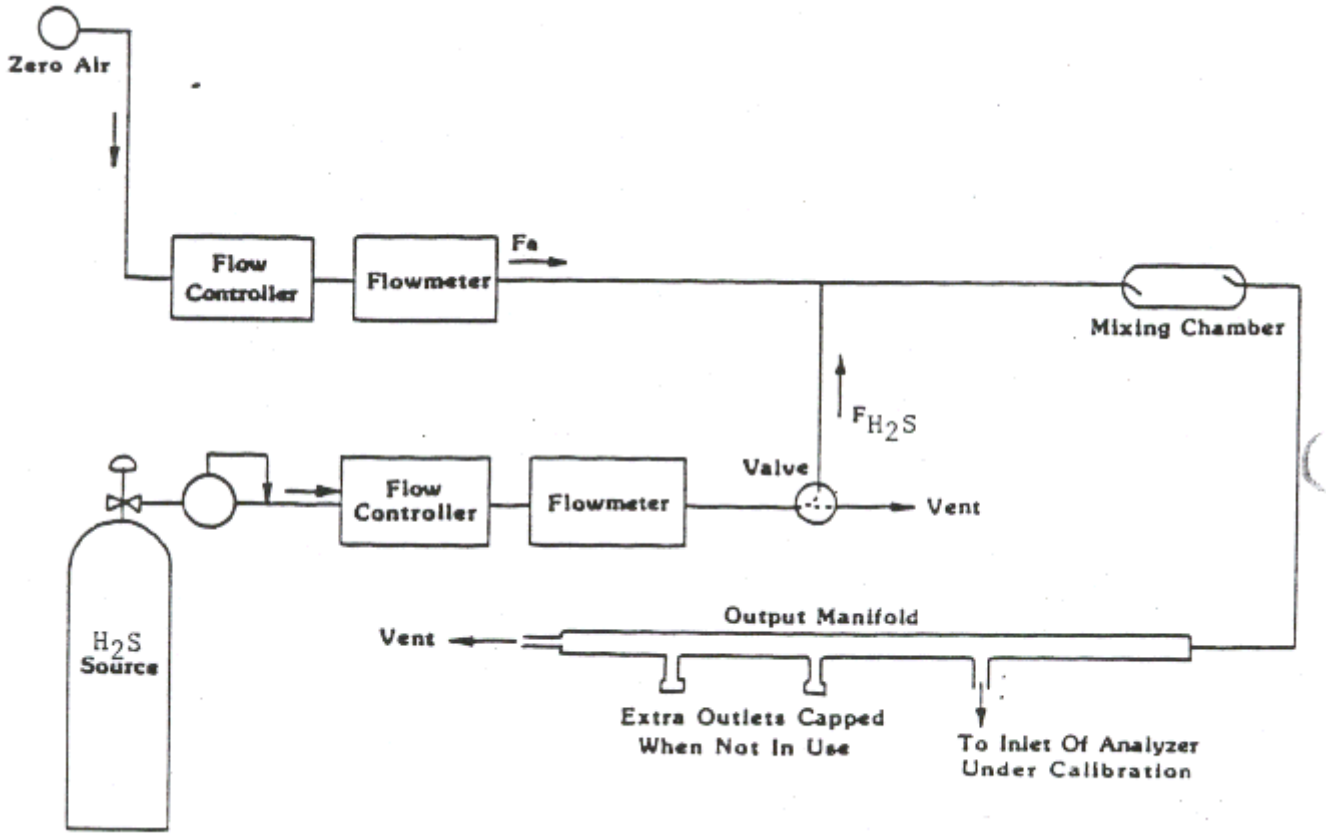

Figure O.3.0.2
Diagram of a Typical H_2S Dynamic Calibration System